Report

Air Quality Review and Assessment - Stage 3

A report produced for Limavady Borough Council

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Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality. The NI Environment Order came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy. The Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. New national air quality standards have been proposed by the Expert Panel on Air Quality Standards (EPAQS) for the UK.

All local authorities are thus required to undertake an air quality review. In areas where air quality objectives are not anticipated to be met by the specified date, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

The Local Air Quality Management Policy Guidance (LAQM.PGNI (03)) is designed to help relevant authorities with their local air quality management duties under Part III of the environment (NI) Order 2002. The guidance sets out the legislative framework for the system of local Air quality Management (LAQM). The Environment (NI) Order 2002 provides the framework for LAQM across Northern Ireland.

The air Quality Objectives set out in the Air Quality Regulations (NI) 2003 provide the statutory basis for the system of LAQM.

The first step in this process is to undertake a review of current and potential future air quality. The number of reviews necessary depends on the likelihood of achieving the objectives.

This report on domestic fuel combustion forms part of the stage three air quality review for Limavady Borough Council. Only PM_{10} and sulphur dioxide are considered in this report. This is because PM_{10} and sulphur dioxide are the only pollutants of concern when considering domestic fuel combustion. This report investigates PM_{10} and sulphur dioxide levels through an examination of the location and size of domestic combustion sources, emissions modelling exercises and by reference to monitored air quality data.

As part of this report, detailed modelling using ADMS version 3.1 has been undertaken at two one kilometre square grids identified in the Stage 2 assessment. These are:

- 1 – Limavady
- 2 - Dungiven

The model results have been bias corrected using data from Spring Hill Park in Strabane because there is no continuous monitoring at present of SO_2 and PM_{10} in the Limavady Borough. This will provide indicative results and will alert Limavady Borough Council if concentrations in the borough are likely to exceed the objectives and therefore whether local monitoring should be undertaken.

Particulates (PM_{10})

The modelling results suggest that there will be an exceedence, of the 90.4 percentile daily mean PM_{10} objective in 2004 in one of the areas modelled, the Limavady area. The model results suggest that an exceedence of the 90.4 percentile daily mean is not likely in the Dungiven area. This is the most stringent of the PM_{10} objectives. If this objective is met then it is likely that the annual mean objective in 2004 will also be met. Therefore it is suggested that a monitoring station is set up in a high density domestic coal burning area in the Limavady area, so that concentrations can be closely observed.

It is recommended that a monitoring station is set up in the Limavady area so that PM_{10} concentrations from domestic fuel burning can be monitored to establish if an air quality

management area (AQMA) is needed in Limavady. It is also recommended that data from the Limavady monitoring station is then used to verify the current model results in both the Limavady and Dungiven areas.

Sulphur dioxide

The modelling results suggest that there will not be an exccedence of the 15 minute mean SO2 objective in either of the Limavady or the Dungiven areas. This is the most stringent SO_2 objective and so it is likely that the hourly and daily SO_2 objectives will also be met.

It is not recommended that Limavady Borough Council consider declaring an AQMA for sulphur dioxide from domestic fuel burning.

Maps reproduced within this document

Acronyms and definitions

ADMS	an atmospheric dispersion model
AQDD	Common Position on Air Quality Daughter Directives
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AUN	Automatic Urban Network
d.f.	degrees of freedom
DEFRA	Department for the Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
GIS	Geospatial Information System
n	number of pairs of data
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Strategy (now called the Air Quality Strategy)
netcen	National Environmental Technology Centre
ppb	parts per billion
r	the correlation coefficient
roadside	1 to 5 m from the kerb
LBC	Limavady Borough Council

Contents

1. Introduction

1.1 PURPOSE OF THE STUDY

AEA Technology's National Environmental Technology Centre (netcen) was commissioned to complete the domestic fuel combustion section of the third stage review and assessment for Limavady Borough Council (LBC).

1.2 GENERAL APPROACH TAKEN

The approach taken in this study was to:

- Collect and interpret additional data to support the third stage assessment, including detailed fuel use survey data for locations where exceedences were predicted;
- Utilise the monitoring data from a monitoring station in Strabane near to Limavady to assess the ambient concentrations produced by domestic fuel combustion and to validate the output of the modelling studies. Data from Strabane was used because no monitoring data from Limavady was available;
- Model the concentrations of PM_{10} and SO_2 in the selected grid squares, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots of concentrations.

1.3 VERSION OF THE POLLUTANT SPECIFIC GUIDANCE USED IN THIS ASSESSMENT

This report has used the guidance in LAQM.TG(03), published in February 2003.

1.4 NUMBERING OF FIGURES AND TABLES

The numbering scheme is not sequential, and the figures and tables are numbered according to the chapter and section that they relate to.

1.5 UNITS OF CONCENTRATION

The units throughout this report are presented in $\mu g\ m^{-3}$ (which is consistent with the presentation of the new AQS objectives), unless otherwise noted.

1.6 STRUCTURE OF THE REPORT

This document is a Third Stage Air Quality review for Limavady Borough Council for PM_{10} and SO_2 from domestic fuel combustion. This chapter, Chapter 1 has summarised the approach to completing the study.

Chapter 2 of the report describes the most recent developments in the UK's Air Quality Strategy (AQS). In addition, it discusses when implementation of an AQMA is required.

Chapter 3 contains details of the information used to conduct the stage 3 review and assessment for Limavady Borough Council.

Chapters 4 and 5 describe the review and assessment standards for the two relevant pollutants, SO_2 and PM_{10} and the monitoring data used for these pollutants.

Chapter 6 presents the fuel use survey results.

Chapter 7 presents the detailed modelling. The results of this analysis are displayed as contour plots.

2 The updated Air Quality Strategy

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

After agreement of a Common Position on the Air Quality Daughter Directives (AQDD), in June 1998 at the European Union Environment Council, the government published its proposals for review of the National Air Quality Strategy (in 1999). Subsequently the Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in January 2000.

The NI Environment Order came into operation in January 2003 and implements both the European Air Framework Directive 96/62EC and the UK Air Quality Strategy. The Expert Panel on Air Quality Standards (EPAQS) has proposed new national air quality standards for the UK.

The NI Environment Order 2002 provides the framework for LAs to review air quality and for implementation of an AQMA. It is issued by the Department of the Environment in Northern Ireland under Article 16 of the Environment (NI) Order 2002. Under article 16 of the order, District Councils and other relevant authorities are required to have regard to this guidance when carrying out any of their duties under, or by virtue of Part III of the order. The guidance the document sets out is outlined in Table 2.1 below.

Table 2.1: NI Environment Order 2002 key Guidance:

- The statutory background and the legislative framework within which relevant authorities have to work
- The new principles behind reviews and assessments of air quality up to 2010 and the recommended steps that relevant authorities should take
- The timetable for reviews and assessments up to 2010
- How district councils should handle the designation of AQMAs
- How relevant authorities should handle the drawing up and implementation of action plans
- Recommendations and suggestions on taking forward the development of local and regional air quality strategies
- Suggestions of how relevant authorities should consult and liase with others
- Local transport measures which Roads Service might wish to consider
- The general principles behind air quality and land use planning; and
- How enforcing authorities should use powers of entry under Article 19 of the Order

2.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE NATIONAL AIR QUALITY STRATEGY

The main elements of the AQS can be summarised as follows:

- The use of a health effects based approach using national air quality standards and objectives.
- The use of policies by which the objectives can be achieved and which include the input of important actors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with target dates of 2003, 2004, 2005, 2008 and 2010 for the achievement of objectives and a commitment to review the Strategy every three years.

It is intended that the AQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles which include:

- the provision of a statement of the Government's general aims regarding air quality;
- clear and measurable targets;
- a balance between local and national action and
- a transparent and flexible framework.

Co-operation and participation by different economic and governmental sectors is also encouraged within the context of existing and potential future international policy commitments.

2.2.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 2.2. The table shows the standards in $\mu g\ m^{-3}$ with the number of exceedences that are permitted (where applicable).

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedences of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as November 5th. For example, if an objective is to be complied with at the 99.9th percentile, then 99.9% of measurements at each location must be at or below the level specified.

Table 2.2. Proposed Objectives included in the Air Quality Regulations (NI) 2003 for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 μgm^{-3}	Running annual mean	31.12.2003
	3.25 μgm^{-3}	Running annual mean	31.12.2010
1,3 Butadiene	2.25 μgm^{-3}	Running annual mean	31.12.2003
Carbon Monoxide	10.0 mgm^{3}	Maximum daily running 8-hour mean	31.12.2003
Lead	0.5 μgm^{-3}	Annual mean	31.12.2003
	0.25 mgm3	Annual mean	31.12.2008
Nitrogen Dioxide[1]	200 μgm^{-3} no to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 μgm^{-3}	annual mean	31.12.2005
Particles (PM_{10})[2] **Gravimetric**[3]	50 μgm^{-3} not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 μgm^{-3}	annual mean	31.12.2004
Sulphur Dioxide	350 μgm^{-3} not to be exceeded more than 24 times per year	1 hour mean	31.12.2004
	125 μgm^{-3} not to be exceeded more than 3 times per year	24 hour mean	31.12.2004
	266 μgm^{-3} not to be exceeded more than 35 times per year	15 minute mean	31.12.2005

Notes
1. The objectives for nitrogen dioxide are provisional.
2. There are likely to be new particles objectives for 2010, not in regulation at present, expected after the review of the EU's first Air Quality Daughter Directive (2004).
3. Measured using the European gravimetric transfer standard or equivalent.

2.2.2 Relationship between the UK National Air Quality Standards and EU air quality Limit Values

As a member state of the EU, the UK must comply with European Union Directives.

There are three EU ambient air quality directives that the UK has transposed in to UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management. (the Ambient Air Framework Directive)
- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter and lead in ambient air. (the First Daughter Directive)
- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and carbon monoxide in ambient air. (the Second Daughter Directive)

The first and second daughter directives contain air quality Limit Values for the pollutants that are listed in the framework directive. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK air quality strategy should allow the UK to comply with the EU Air Quality Daughter Directives, but the UK air quality strategy also includes some stricter national objectives for some pollutants, for example, sulphur dioxide.

The Government is ultimately responsibility for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in those EU Directives.

2.2.3 Policies in place to allow these objectives to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies which already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2010. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power stations will meet the air quality standards set out in the AQS. Northern Ireland now has in place the Air Quality Limit Value regulation (NI) 2002, the Air Quality (Amended) Limit Value Regulations (NI) 2002 and the Air Quality (Ozone) Regulations (NI) 2003. The Government has recognised the problems associated with achieving the standard for ozone, a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

Local air quality management provides a strategic role for local authorities in response to particular air quality problems experienced at a local level. This builds upon current air quality control responsibilities and places an emphasis on bringing together issues relating to transport, waste, energy and planning in an integrated way. This integrated approach involves a number of different aspects. It includes the development of an appropriate local framework that allows air quality issues to be considered alongside other issues relating to polluting activity. It should also enable co-

operation with and participation by the general public in addition to other transport, industrial and governmental authorities.

An important part of the Strategy is the requirement for local authorities to carry out air quality reviews and assessments of their area against which current and future compliance with air quality standards can be measured. Over the longer term, these will also enable the effects of policies to be studied and therefore help in the development of future policy. The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their Borough. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.2.4 Timescales to achieve the objectives

In most local authorities, objectives will be met for most of the pollutants within the timescale of the objectives shown in Table 2.2. It is important to note that the objectives for NO_2 remain provisional.

2.3 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes the Technical Guidance LAQM.TG(03), and the previous version LAQM.TG4(00) May 2000, on 'Review and Assessment: Pollutant Specific Guidance'. This review and assessment has considered the procedures set out in the guidance.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives.

At present Northern Ireland District Councils are engaged in the 3 staged approach of review and assessment. Stage 1 equates to an 'updating and Screening assessment, and a stage 2 and 3 equates to a 'detailed assessment'. The Stages are briefly described in Table 2.3. The latest technical guidance LAQM.TG(03) is based on a revised '2 step' approach. The Steps are briefly described in Table 2.3B.

The department recommends that district councils where feasible should use the latest technical guidance LAQM.TG(03) to complete their first rounds of review and assessment. Where District councils have commenced using the old technical guidance (LAQM. TG4 (00)) they may continue using the old guidance. However the methodology should be cross-referenced with the new guidance.

In the stage 2 review and assessment (Hobson and Haigh, 2002), LBC identified 1x1km areas of potential exceedence of air quality objectives for SO_2 and PM_{10} following LAQM.TG4 (00). The latest guidance, LAQM.TG (03) requires the assessment to be carried out in greater detail by considering 500x500m areas. The detailed modelling carried out in this Stage 3 uses the 1x1km areas, but this takes account of all areas of significant domestic solid fuel burning. In practice, the high resolution modelling and the method of source definition used in this report means that defining a 1x1km area makes no difference to the output when compared with a smaller total area. This is because the source within that is modelled the same as it would be if the area were over a smaller total area, e.g. 500mx500m.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process

Stage	Objective	Approach	Outcome
First Stage Review and Assessment	• Identify all significant pollutant sources within or outside of the authority's area.	• Compile and collate a list of potentially significant pollution sources using the assessment criteria described in the Pollutant Specific Guidance	
	• Identify those pollutants where there is a **risk** of exceeding the air quality objectives, and for which further investigation is needed.	• Identify sources requiring further investigation.	• Decision about whether a Stage 2 Review and Assessment is needed for one or more pollutants. If not, no further review and assessment is necessary.
Second Stage Review and Assessment	• Further screening of significant sources to determine whether there is a significant risk of the air quality objectives being exceeded.	• Use of screening models or monitoring methods to assess whether there is a risk of exceeding the air quality objectives.	
	• Identify those pollutants where there is a **risk** of exceeding the objectives, and for which further investigation is needed.	• The assessment need only consider those locations where the highest likely concentrations are expected, and where public exposure is relevant.	• Decision about whether a Stage 3 Review and Assessment is needed for one or more pollutants. If, as a result of estimations of ground level concentrations at suitable receptors, a local authority judges that there is no significant risk of not achieving an air quality objective, it can be confident that an Air Quality Management Area (AQMA) will not be required. • However, if there is doubt that an air quality objective will be achieved a third stage review should be conducted.

Table 2.3 (contd.) Brief details of Stages in the first Review and Assessment process

Stage	Objective	Approach	Outcome
Third Stage Review and Assessment	• Accurate and detailed assessment of both current and future air quality. Assess the **likelihood** of the air quality objectives being exceeded.	• Use of validated modelling and quality-assured monitoring methods to determine current and future pollutant concentrations.	
	• Identify the geographical boundary of any exceedences, and description of those areas, if any, proposed to be designated as an AQMA.	• The assessment will need to consider all locations where public exposure is relevant. For each pollutant of concern, it may be necessary to construct a detailed emissions inventory and model the extent, location and frequency of potential air quality exceedences.	• Determine the location of any necessary Air Quality Management Areas (AQMAs). Once an AQMA has been identified, there are further sets of requirements to be considered. • A further assessment of air quality in the AQMA is required within 12 months which will enable the degree to which air quality objectives will not be met and the sources of pollution that contribute to this to be determined. A local authority must also prepare a written action plan for achievement of the air quality objective. Both air quality reviews and action plans are to be made publicly available.

Table 2.3B Brief details of Steps in the revised Air Quality Review and Assessment process

Level of Assessment	Objective	Approach
Updating and Screening Assessment (USA)	• To identify those matters that have changed since the last review and assessment, which might lead to a risk of an air quality objective being exceeded.	• Use a checklist to identify significant changes that require further consideration. • Where such changers are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence of an objective to justify a detailed assessment.
Detailed Assessment	• To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs.	• Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.

2.4 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.4 summarises the locations where the objectives should and should not apply.

Table 2.4 Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building facades of offices or other places of work where members of the public do not have regular access.
		• Building facades of residential properties, schools, hospitals, libraries etc.	• Gardens of residential properties.
			• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	

Table 2.4 (contd.) Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives should apply at …	Objectives should generally not apply at …
1 hour mean	• Nitrogen dioxide • Sulphur dioxide	• All locations where the annual mean and 24 and 8-hour mean objectives apply.	• Kerbside sites where the public would not be expected to have regular access.
		• Kerbside sites (e.g. pavements of busy shopping streets).	
		• Those parts of car parks and railway stations etc. which are not fully enclosed.	
		• Any outdoor locations to which the public might reasonably expected to have access.	
15 minute mean	• Sulphur dioxide	• All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedences of the objectives at any location where public exposure over the relevant averaging period would be unrealistic, and the locations should represent non-occupational exposure.

Key Points

- The Environment (Northern Ireland) Order 2002 has required the development of a National Air Quality Strategy for the control of air quality
- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.
- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various actors and agencies involved.
- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2010.
- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives.

3 Information used to support this assessment

This Chapter presents the information used to support this review and assessment.

3.1 MAPS

Limavady Borough Council provided detailed maps of the two kilometre grid squares of concern. The areas include areas of significant coal burning in the Borough.

3.2 METEOROLOGICAL DATA USED IN THE DISPERSION MODELLING

Hourly sequential data was obtained for 1999 from the Meteorological Office for the Aldergrove site for input into the ADMS dispersion model.

3.3 AMBIENT MONITORING

3.3.1 Particulates (PM_{10})

PM_{10} has been monitored:

- By continuous monitoring since April 2002 in Strabane District at Springhill Park (OS Grid Reference 2351 3972) located approximately 40km from Limavady Borough. Monitoring data from this location was used because no monitoring data was available from Limavady.

The concentrations recorded by the continuous monitor are provided in Section 4.4.

3.3.2 Sulphur dioxide

Sulphur dioxide has been monitored by:

- By continuous monitoring since April 2002 in Strabane District at Springhill Park (OS Grid Reference 2351 3972) approximately 40km from Limavady. Monitoring data from this location was used because no monitoring data was available from Limavady.

The concentrations recorded by the continuous monitor are provided in Section 5.4.

A fuel use survey for the areas to be modelled, described in chapter 6, has also been used to support the assessment.

4 Review and Assessment for PM_{10} from domestic fuel combustion

4.1 INTRODUCTION

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles are often classed as either primary (those emitted directly into the atmosphere) or secondary (those formed or modified in the atmosphere from condensation and growth). PM_{10} particles (the fraction of particulates in air of very small size, <10 µm aerodynamic diameter) can potentially pose significant health risks as they are small enough to penetrate deep into the lungs. Larger particles are not readily inhaled.

A major source of fine primary particles is combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler tailpipe or stack can lead to spontaneous nucleation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1 µm in diameter.

Concern about the potential health impacts of PM_{10} has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring the smaller particle fraction, $PM_{2.5}$, which is capable of penetrating deepest into the lungs, or to even smaller size fractions or total particle numbers.

4.2 LATEST STANDARDS AND OBJECTIVES FOR PM10

The government and the devolved administrations have adopted two air quality objectives for fine particles (PM_{10}), which are the equivalent to the EU Stage 1 limit values in the first Air Quality Daughter Directive. The gravimetric objectives are:

- An annual mean of 40 $\mu g/m^3$.
- A 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 35 days per year.

The EU has also set indicative limit values for PM_{10} which are to be achieved by 1st January 2010. These stage 2 limit values are considerably more stringent and are:

- For England, Wales and Northern Ireland (except London), a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 7 days per year and an annual mean of 20 $\mu g/m^3$ to be achieved by the end of 2010;
- For London, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 days per year and an annual mean of 23$\mu g/m^3$ to be achieved by the end of 2010. An annual mean objective of 20$\mu g/m^3$ to be achieved by the end of 2015 has also been set.

The 24 hour objective is more stringent than the annual mean objective in 2004. However, the opposite is true in 2010, and the annual mean objective is more stringent than the 24 hour objective. However there is no requirement for local authorities to achieve the 2010 objectives.

4.3 THE NATIONAL PERSPECTIVE

National UK emissions of primary PM_{10} have been estimated as totalling 208,000 tonnes in 2001. Of this total, around 17% was derived from road transport sources, 9% from power stations and 16% from domestic and other low-power combustion. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999). APEG concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 $\mu g\ m^{-3}$ associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

4.4 MONITORING DATA

PM_{10} concentrations have been continuously monitored in Strabane District located approximately 40 km from Limavady at Springhill Park since April 2002 (OS Grid Reference 2351, 3972).

All the PM_{10} concentrations presented and used in this study are in gravimetric equivalents. A summary of the PM_{10} concentrations recorded by the continuous monitor is provided in Table 4.4 below.

QA/QC of continuous monitoring data
The data from the continuous monitor located at Springhill Park has been ratified by netcen. The data conforms to the QA/QC standards used in the Defra network.

Summary statistics
Table 4.4 shows the daily average measured concentrations from the 26th April 2002 until the 25th April 2003. The average concentration (ratified) for the Springhill site in Strabane exceeds the annual and 24 hour objective for PM_{10}.

Table 4.4 Summary of continuous PM_{10} ratified data from the 26th April 2002 to the 25th April 2003 inclusively. Concentrations are in gravimetric equivalents.

	Concentration, $\mu g\ m^{-3}$
	PM_{10}
Average over period	45
90 %ile of 24hour mean	85
Data capture	96.9%

4.5 COMPARISON OF MONITORING DATA WITH DERRY

The modelling carried out for this report (section 6) has used 1999 meteorological data from Aldergrove. Therefore a comparison has been made between PM_{10} concentrations recorded by the continuous monitor in Derry in 1999 with that recorded between 26th April and the 25th April 2003 when the Springhill Park site was in operation. Ideally a comparison would have been done with more monitoring sites but Derry was the only site for which data was available and for which was deemed suitable. The results are shown in Table 4.5 below. All results shown are in gravimetric equivalents.

Table 4.5 Comparison of PM_{10} concentrations in Springhill Park with the Derry site.

Site	90th percentile daily mean ($\mu g/m^3$) in 1999	90th percentile daily mean ($\mu g/m^3$) from 26th April 2002 to 25th April 2003
Derry	39	43
Springhill Park	*	85

* It is estimated that in 1999, Springhill Park would have recorded a 90th percentile daily mean PM_{10} concentration of approximately 77.1 $\mu g/m^3$. This result has been used in the modelling to correct for bias.

5 Review and Assessment for SO_2 from domestic fuel combustion

5.1 INTRODUCTION

Sulphur dioxide is a corrosive acid gas which combines with water vapour in the atmosphere to produce acid rain. Both wet and dry deposition have been implicated in the damage and destruction of vegetation and in the degradation of soils, building materials and watercourses. SO_2 in ambient air is also associated with asthma and chronic bronchitis.

The principal source of this gas is power stations burning fossil fuels which contain sulphur. Episodes of high concentrations of SO_2 now only tend to occur in cities in which coal is still widely used for domestic heating, in industry and in power stations. As most power stations are now located away from urban areas, SO_2 emissions may affect air quality in both rural and urban areas. Since the decline in domestic coal burning in cities and in power stations overall, SO_2 emissions have diminished steadily and, in most European countries, they are no longer considered to pose a significant threat to health.

5.2 LATEST STANDARDS AND OBJECTIVES FOR SO2

Two new objectives have been introduced for SO_2 in the AQS based on the limit values in the Air Quality Daughter Directive. Hence there are now three objectives:

- 266 $\mu g\ m^{-3}$ as a 15 minute mean (maximum of 35 exceedences a year or equivalent to the 99.9^{th} percentile) to be achieved by the 31^{st} December 2005
- 350 $\mu g\ m^{-3}$ as a 1 hour mean (maximum of 24 exceedences a year or equivalent to the 99.7^{th} percentile) to be achieved by the 31^{st} December 2004
- 125 $\mu g\ m^{-3}$ as a 24 hour mean (maximum of 3 exceedences a year or equivalent to the 99^{th} percentile) to be achieved by the 31^{st} December 2004

The 15 minute mean objective is the most stringent; the other two objectives will not be exceeded if this objective is not exceeded.

5.3 THE NATIONAL PERSPECTIVE

Sulphur dioxide is emitted in the combustion of coal and oil. Emissions today are dominated by fossil-fuelled power stations which in 2001 accounted for 61% of the national total emission. Emissions from road transport are a very small fraction of the national total: 0.3% and domenstic emissions accounted for 4% of the national total.

Exceedences of the 15-minute air quality standard currently occur near industrial processes for which the stack heights were designed to meet previous air quality standards and downwind of large combustion plant such as power stations. Exceedences are also possible in areas where significant quantities of coal are used for space heating. These large combustion plants are currently regulated under BATNEEC and the EPA 1990, and will come under the provisions of the IPPC. The government considers that bearing in mind the envisaged change in fuel use, it does not expect exceedences of the 15-minute objective by 2005 from these sources.

5.4 MONITORING DATA

Sulphur dioxide concentrations have been continuously monitored at Springhill Park in Strabane located approximately 40km from Limavady since April 2002. The site is in a dense domestic fuel burning area. A summary of the concentrations recorded at the site are shown in Table 5.4 below. The data has been ratified by netcen and conform to the Defra standards.

Table 5.4 Summary of continuous SO_2 data 26th April 2002 to the 25th April 2003

	SO_2 ($\mu g/m^3$)
Average	8
Maximum daily mean	29.3
Maximum hourly mean	90.4
99.9th %ile 15 minute mean	27
Data capture	93.4%

The most stringent SO_2 objective is the 99.9 percentile 15 minute mean. If this objective is met then it is likely that all the other objectives will be met. The 99.9th % percentile 15 minute mean concentration at the Strabane site was well below the objective of 266 $\mu g/m^3$ for sulphur dioxide during the period of monitoring.

5.5 COMPARISON OF MONITORING DATA WITH BELFAST EAST SITE.

The modelling carried out for this report has used 1999 meteorological data from Aldergrove. Therefore a comparison has been made between SO_2 concentrations recorded by the continuous monitors at Belfast East and Derry in 1999 with that recorded between 26th April and the 25th April 2003 when the Springhill park site in Strabane was in operation. Ideally a comparison would have been done with more monitoring sites but Belfast East and Derry were the only sites for which data was available and which were deemed suitable. The results are shown in Table 5.5 below.

Table 5.5 Comparison of 99.9 percentile 15 minute mean SO_2 concentrations in Springhill park with the Belfast East and Derry sites ($\mu g/m^3$).

Site	**1999**	**26th April 2002 to 25th April 2003**
Belfast East	338	60
Derry	136	35
Springhill Park	*	27

The Belfast East and Derry sites recorded far higher 99.9 percentile 15 minute mean SO_2 concentrations in 1999, than during April 2002 to April 2003 when the Springhill site has been in operation. Therefore it is likely that this period of monitoring is unrepresentative of the norm.

* It is estimated that in 1999, Springhill Park would have recorded a 99.9 percentile 15 minute mean SO_2 concentration of approximately 128.5 $\mu g/m^3$. This figure has been used to bias correct the modelled results.

6 Results of the fuel use survey

6.1 INTRODUCTION

Limavady Borough Council commissioned Foyle Regional Energy Agency to carry out a domestic fuel survey in three areas identified in the Stage 2 Review and Assessment. Two of these areas were then identified as requiring modelling.

The survey aimed to determine the following:

- The types and quantities of fuels used in the domestic sector
- Seasonal use of heating fuels
- The types of heating appliances used
- Any proposed change in fuel usage
- Tenure type
- The total number of persons who live in coal burning households in each of the three designated survey areas.
- The total number of houses that burn coal in each of the survey areas.

The two survey areas considered for modelling were:

- Limavady (including Coolenssan, Greystone and part of Enagh ward)
- Dungiven

The aim was to sample 25% of all properties within these three 1km^2 areas with at least a 75% response rate, using a quota sampling strategy.

Table 6.1 Estimated number of houses in each grid area and the achieved number of surveys.

Grid Area	No. houses	Target response rate	Number of respondents
Limavady	1471	276	276
Dungiven	841	158	164

The results of the survey showed that in the Limavady grid, oil was the most popular primary heating source (66% of all households). Coal accounted for 29% of all households as the main heating source and an additional 46% of households reported using coal as a secondary heating source. In the Dungiven grid, the survey results showed 87% of all households used oil as their primary heat source and 13% used coal. 55% of households reported using coal as a secondary source of heat.

6.2 EMISSION FACTORS USED IN THE MODELLING

The SO_2 and PM_{10} emissions arising from domestic fuel combustion were taken from the UK emission factor database (www.naei.org.uk). This web site is managed by netcen on behalf of defra. The exception to this is the emission factor for sulphur dioxide from household coal, which has been taken from a CRE study carried out for Belfast City Council. This locally derived emission factor is more representative of fuel burnt in Northern Ireland.

Table 6.2 Emissions arising from domestic fuel combustion

Fuel type	SO2	PM10	Units
Anthracite	13	3.59	kt/mt fuel burnt
Burning Oil	0.42	0.01	kt/mt fuel burnt
Coal	10*	10	kt/mt fuel burnt
SSF	16	5.6	kt/mt fuel burnt

Source: UK emission factor database (www.naei.org.uk)
SSF = solid smokeless fuel
* - emission factor taken from CRE, 1997.

The emission factors provided in the above table have been used to derive PM_{10} and SO_2 emissions for both survey areas.

6.3 GRID 1 - LIMAVADY

In Grid square 1, there were estimated to be 1471 households. The following two tables summarise the results of the survey in this grid. Appendix 1 provides further details.

Table 6.3A % of households burning different fuel types in the Limavady grid.

Use	oil	gas	Electricity	coal/SF	Total
Main fuel	66	0	5	29	100
Secondary fuel	3	16	35	46	100

SF = solid fuel

Table 6.3B The type of coal and / or solid smokeless fuel used (%) in the Limavady survey area.

Type	Anthracite	Household coal	Smokeless
% who use	37	34	29

In the Limavady survey area, it was found that the majority (66%) of households burned oil as their primary fuel. A smaller proportion (29%) burnt coal or solid fuel.

The emission factors shown in Table 6.2 above have been applied to the results of the fuel survey for grid square 1 to calculate an average PM_{10} and SO_2 emission arising from each block of housing in the area.

6.4 GRID 2 - DUNGIVEN

In Grid square 2, there were estimated to be 841 households. The following two tables summarise the results of the fuel survey in this grid 2. For further details please see Appendix 1.

Table 6.4A % of households burning different fuel types in Ballycolman.

Use	**oil**	**Gas**	**elec**	**coal/SF**	**Total**
Main fuel	87	0	0	13	100
Secondary fuel	30	10	5	55	15

Table 6.4B The type of coal and / or solid smokeless fuel used (%) in Ballycolman

Type	Anthracite	Household	Smokeless
% who use	14	86	0

In the Dungiven survey area it was found that the majority of households burnt oil for their main heating source (87% of households). A lesser proportion burnt coal or solid fuel.

The emission factors shown in Table 6.2 above have been applied to the results of the fuel survey for grid square 2 to calculate an average PM_{10} and SO_2 emission arising from each block of housing in the area.

7 Detailed modelling

7.1 METEOROLOGICAL DATA

Hourly sequential meteorological data for 1999 for Aldergrove was obtained from the Meteorological Office. The meteorological data provided information on wind speed, direction and the extent of cloud cover for each hour of 1999 and temperature.

7.2 OVERVIEW OF THE MODELLING APPROACH

The dispersion model ADMS 3.1 developed by CERC has been used to predict the PM_{10} and SO_2 levels in Limavady Borough. ADMS is a PC-based model that includes an up-to-date representation of the atmospheric processes that contribute to pollutant dispersion and has been deemed suitable for use in the review and assessment process.

The emissions arising from each survey area have been modelled as volume sources 10m high. Emissions have been weighted with both seasonal and diurnal emission patterns. The seasonal pattern was calculated on a degree day basis to weight emissions to the colder periods of the year following the BREDEM model (BREDEM, BRE, 1985). Temperature data for each hour was taken from the 1999 Aldergrove meteorological data.

The modelled concentrations have then been added to estimated background concentrations (taken from the NAEI web site).

7.2.1 Model bias

The monitoring site at Springhill Park, Strabane has been used as a reference site: e.g. model concentrations have been adjusted by taking the ratio between the modelled concentration at the site and the predicted measured value in 1999 from the modelled values at locations in Limavady. The purpose of this adjustment was to ensure that the modelled concentrations equalled the measured values at the monitoring site. A similar methodology was used in the Strabane study to Limavady.

7.2.2 Model validation

The calculations have not taken account of:

- Uncertainties in the fuel use survey as only 15-20% of households were surveyed;
- Uncertainties in how the burning of domestic fuel might change in future years;
- Uncertainty resulting from year to year variations in atmospheric conditions;
- Model errors at the receptor sites;
- Model errors at the reference site;
- Uncertainty in the location of the monitor with respect to local sources
- Monitoring over a short time period
- Uncertainty in emission factors (See section 6.2)

Pollutant emissions are expected to decrease generally due to national measures (which will affect the background concentrations). However, for SO_2 in particular the background contribution is small. Concentration plots are therefore only shown for 1999 as this is the year for which modelling has been

carried out and it is assumed that the results of the survey are applicable to both 1999 and 2004/5. However the Limavady fuel use survey did not provide any predictions of how housing stock and fuel use would change.

7.3 RESULTS OF MODELLING

7.3.1 Limavady

Figure 1 shows predicted SO_2 concentrations in the Limavady area. The model predicts that the 99.9 percentile of the 15 minute mean SO_2 concentration will not be exceeded in any parts of the Borough. It has been assumed that domestic fuel burning in the area will not change between when the survey was carried out and 2004/5.

Figure 1 –99.9 percentile 15 minute mean SO_2 concentrations for the Limavady grid (model results corrected for bias using monitoring data from Strabane)

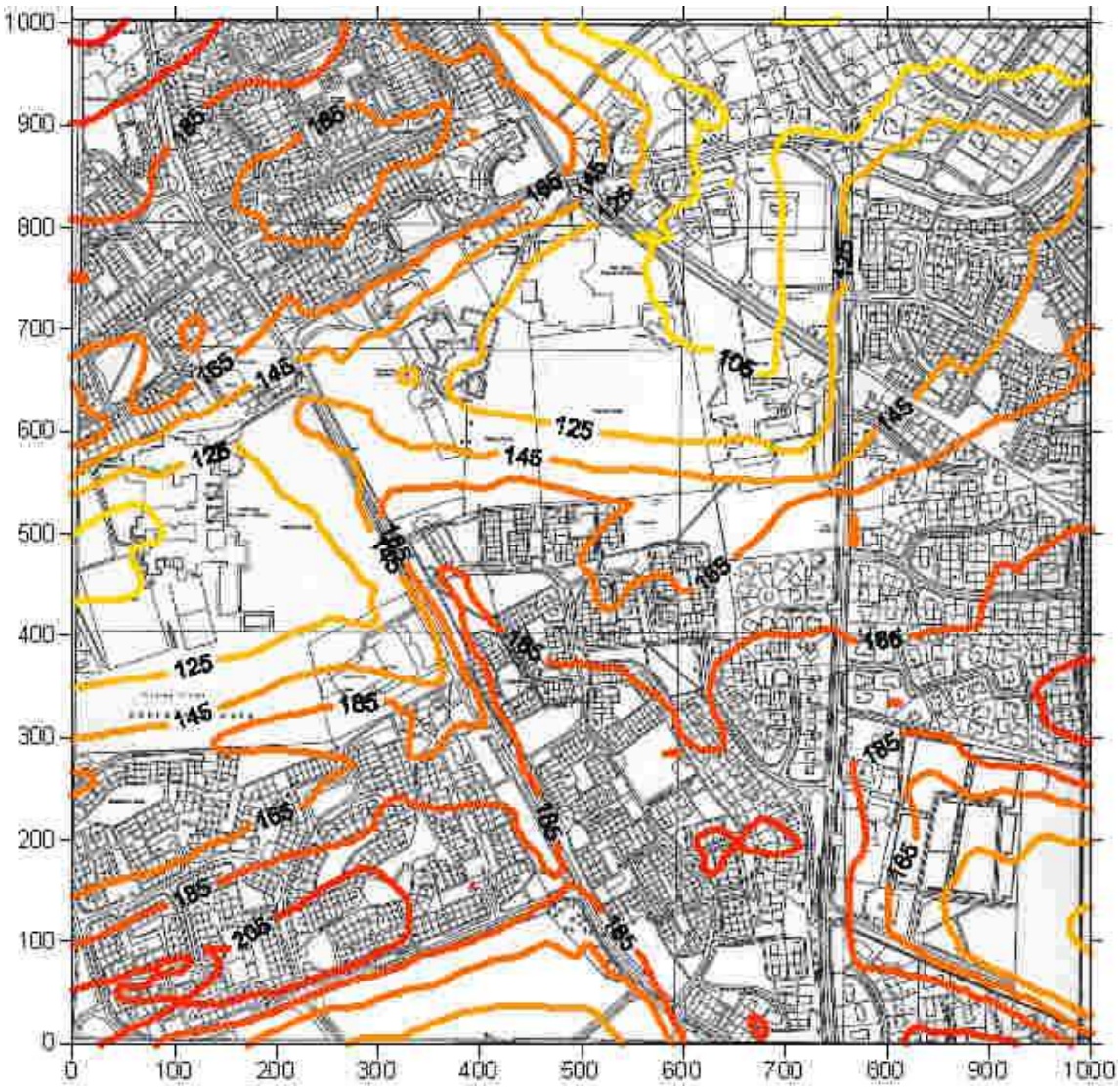
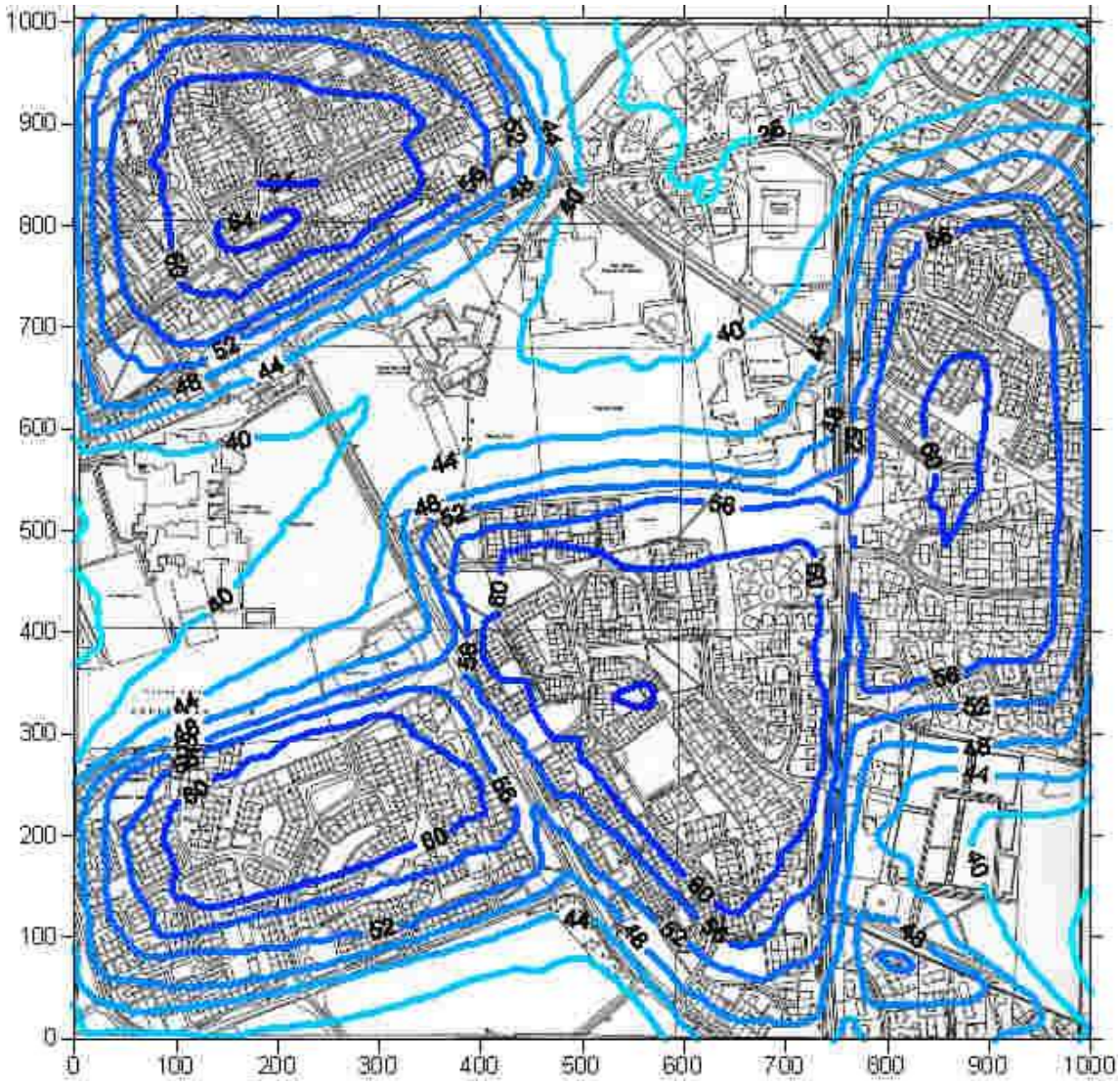


Figure 2 shows the predicted PM_{10} concentrations in the Limavady area. The model predicts that the 90.41 percentile of 24 hour PM_{10} concentrations in 2004 will be exceeded in some parts of this area. It has been assumed that domestic fuel burning in the area will not change between when the survey was carried out and 2004/5

Figure 2 – Predicted 90.4 percentile daily mean PM_{10} concentrations for the Limavady grid (model results corrected for bias using monitoring data from Strabane in 1999)



7.3.2 Dungiven

Figure 3 shows modelled SO_2 concentrations in Dungiven. The model predicts that the 99.9 percentile of the 15 minute mean SO_2 concentrations will not be exceeded in 2004/5.

Figure 3 – 99.9 percentile 15 minute mean SO_2 concentrations for the Dungiven grid (model results corrected for bias using monitoring data from Strabane)

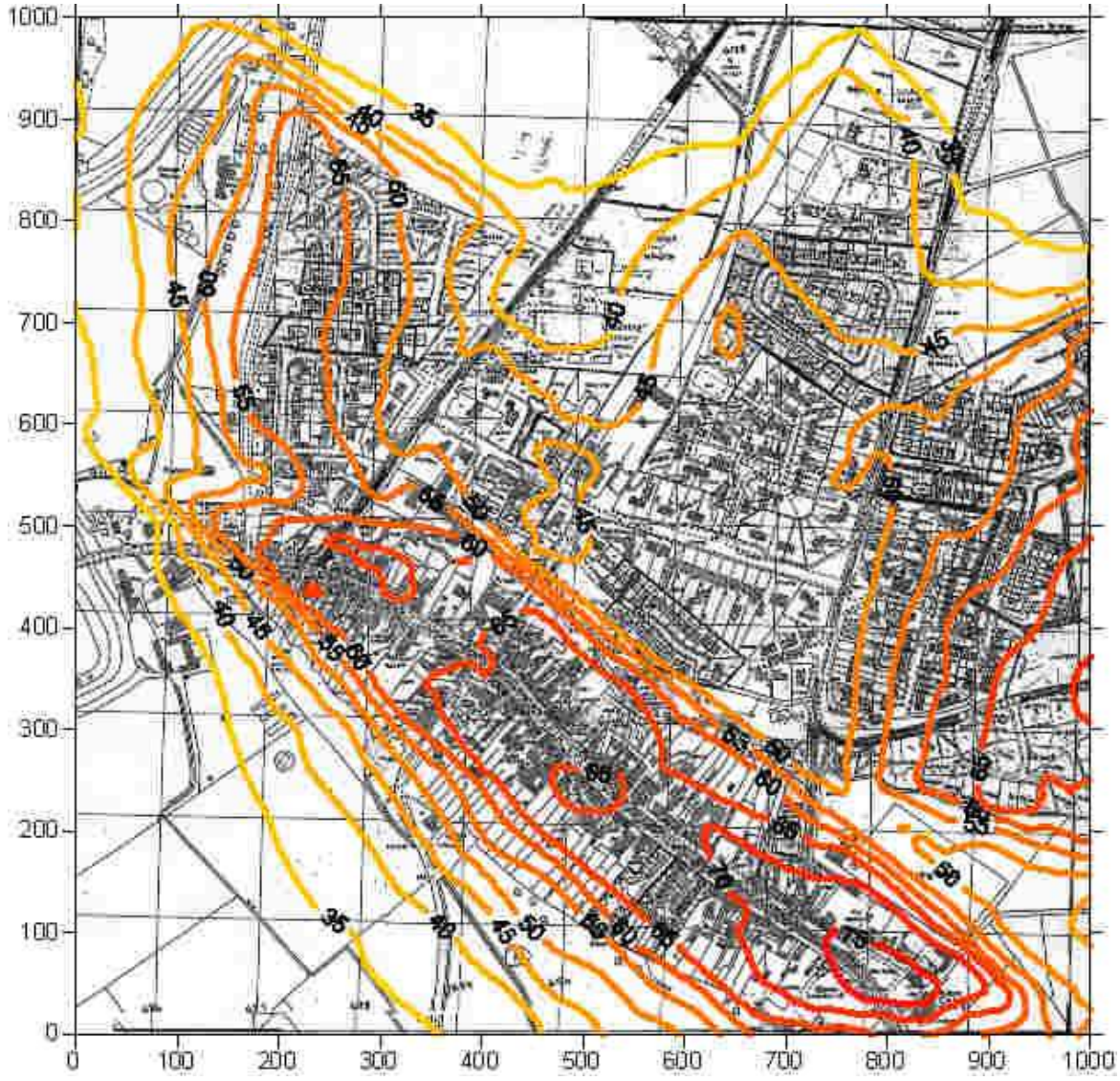
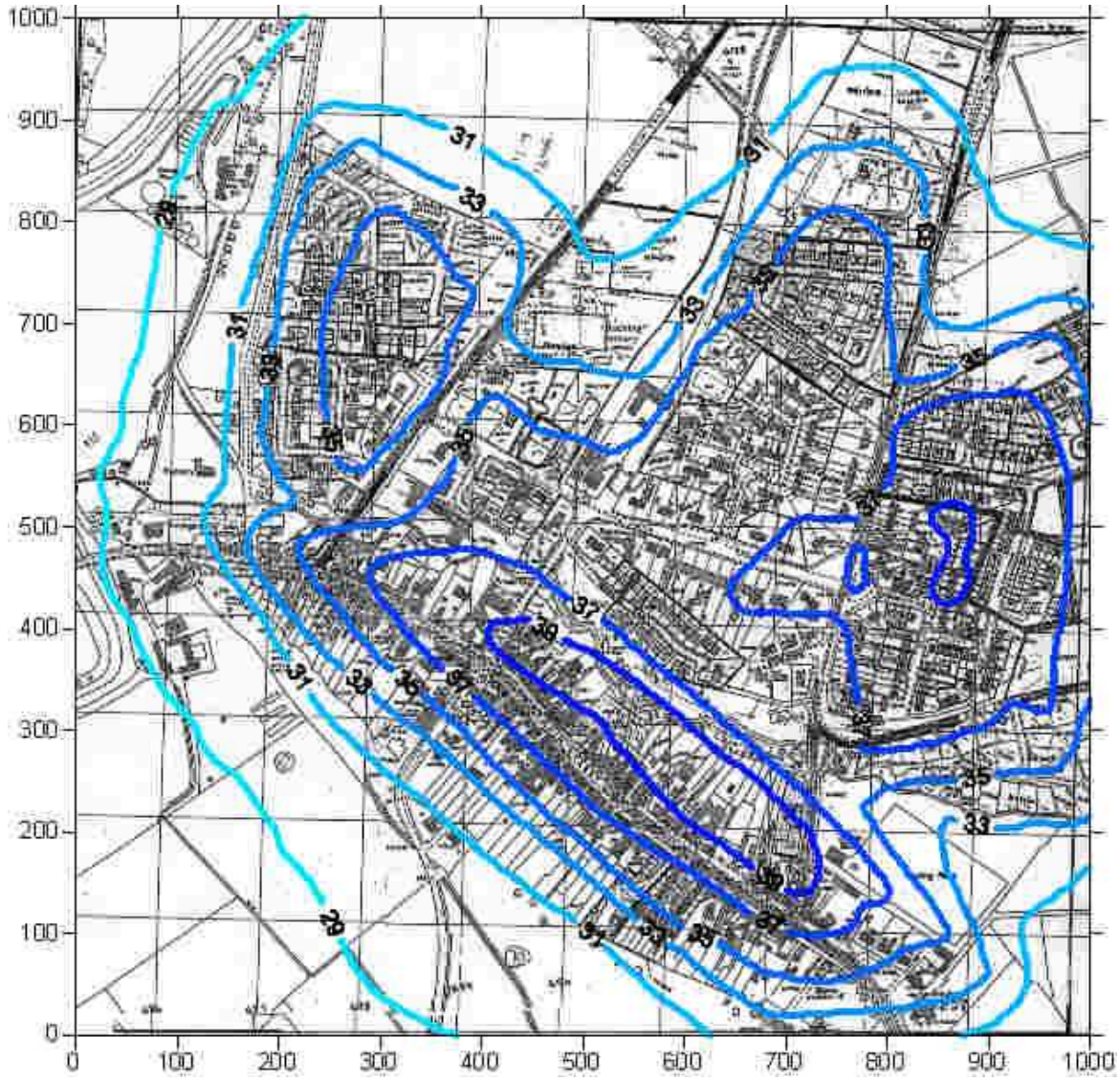


Figure 4 shows modelled PM_{10} concentrations in the Dungiven area in 1999. The model predicts that the 90.41 percentile of 24 hour PM_{10} concentrations will be not be exceeded in this area.

Figure 4 – 90.4 percentile daily mean PM_{10} concentrations for the Dungiven grid (model results corrected for bias using monitoring data from Strabane in 1999)



Higher SO_2 and PM_{10} concentrations were predicted in in the Limavady area because a greater proportion of households burn coal as their primary fuel source (29% of households) compared with in the Dungiven grid (13% of households) and because there is a greater total number of households situated in the Limavady area.

7.4 SUMMARY OF THE LIKELIHOOD OF EXCEEDING THE OBJECTIVES FOR SO_2

Detailed modelling using ADMS version 3.1 has been undertaken at two locations where large amounts of domestic fuel burning is common. The modelling (corrected for bias) predicts that in both the Limavady area and in Dungiven exceedences of the SO_2 objectives are unlikely.

A comparison of the monitoring data recorded at Belfast East during April 2002 to April 2003 (when the continuous monitor at Springhill Park, Strabane was in operation) with data recorded during 1999 showed that during the time that the Strabane site has been in operation, far lower values have been recorded than in previous years. Therefore the data recorded so far at Springhill Park may not be representative of future concentrations.

7.5 SUMMARY OF THE LIKELIHOOD OF EXCEEDING THE OBJECTIVES FOR PM_{10}

Detailed modelling using ADMS version 3.1 has been undertaken at two locations where large amounts of domestic fuel combustion is common.
The modelling (corrected for bias) predicted that in Limavady an exceedence of the PM_{10} objectives in 2004 was likely. In Dungiven the model did not predict an exceedence of the objectives.

7.6 RECOMMENDATIONS

It is recommended that PM_{10} should be monitored in a dense coal burning area in Limavady before deciding if it is necessary to declare an AQMA. It is not recommended that an AQMA is declared for PM10 for Dungiven.

It is not recommended that an AQMA is declared for SO_2 in the Limavady or the Dungiven area.

8 References

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Appendix 1

Limavady Borough Council Fuel Use Survey
Prepared by Foyle Regional Energy Agency, April and May 2003